THE MORPHOLOGY OF THE ALYDID ABDOMEN WITH SPECIAL REFERENCE TO THE GENITALIA AND ITS BEARING ON CLASSIFICATION (HETEROPTERA)

BY

IMTIAZ AHMAD & T. R. E. SOUTHWOOD

Department of Zoology & Entomology, Imperial College, London, England

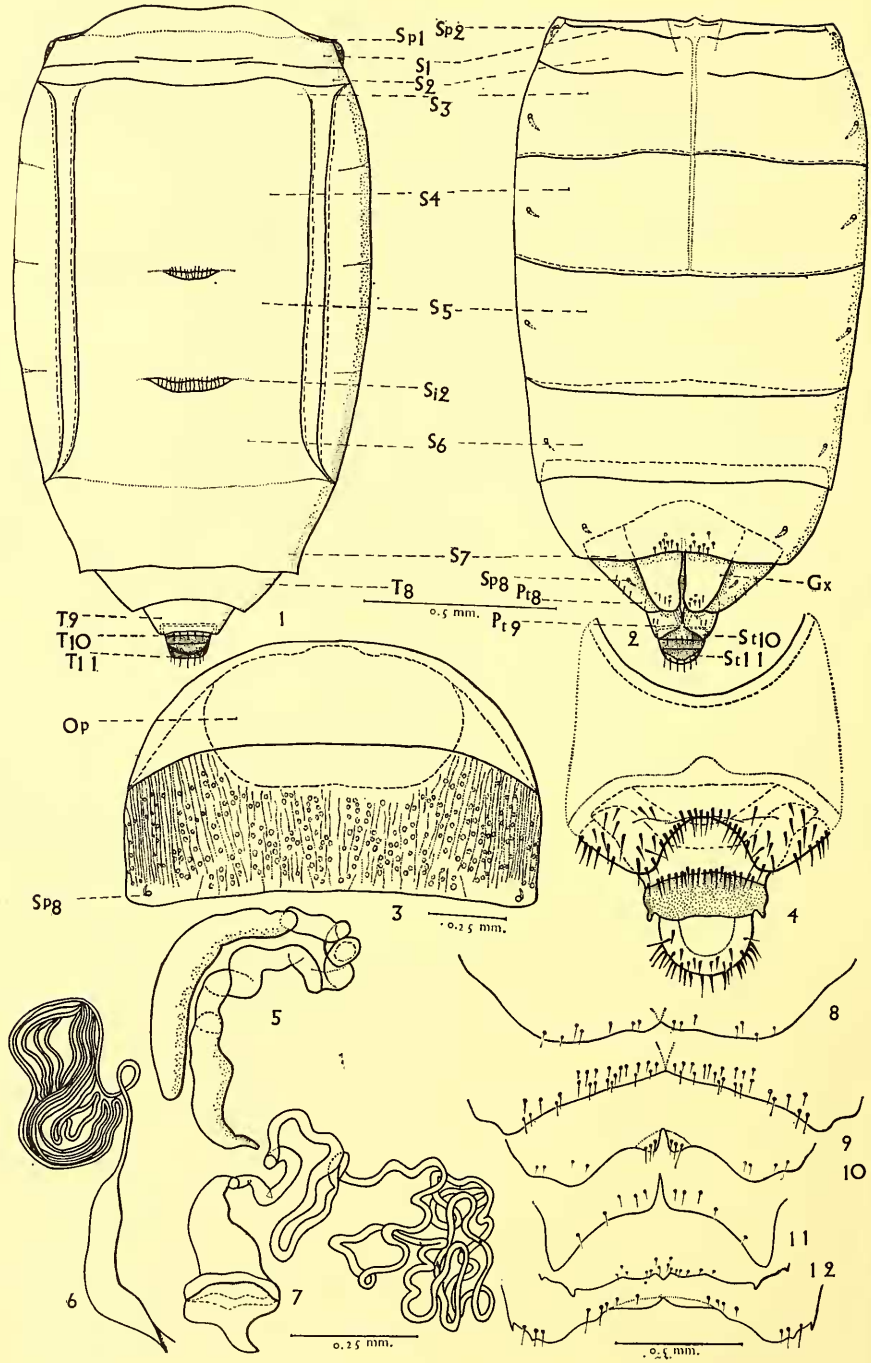
Introduction

Although in the past brief descriptions of the abdomen and genital structures of one or other species of alydid have been made by Crampton (1920 and 1922), Pruthi (1925), Akbar (1958), Scudder (1959) and Stys (1961) there have been no studies to show the range and form of these parts in this family and certain aspects of their morphology have been in dispute. Thus the value of a detailed study of the genitalia for elucidating the classification and taxonomy of the family was unknown, although the shape of the claspers (China, 1924), theis position (Villiers, 1955, 1963) and the shape of the female seventh abdominal sternum and first gonocoxa (Blöte, 1937) have been used.

The object of the present paper is to give a detailed account of the morphology of the abdominal structures of a range of species in the light of recent morphological works on other Heteroptera, e.g., Qadri (1949), Southwood (1953), Leston (1954—55), Slater (1955), Ashlock (1957), and Kelton (1959), and also to determine whether these structures may be used to help define the major taxa below family level. They have been found to be of great value at the specific level and an account of this aspect of the work will be published later.

Material and Method

Specimens used have been preserved either in 70% alcohol or mounted dry. Either the whole abdomen or the genital segments alone were removed and softened in warm 10% potassium hydroxide solution for about one hour. Large structures were washed in water, stained in acid fuchsin in acetic acid and examined in cedarwood oil, methyl benzoate or creosote B.P. It was found that the aedeagus could easily be expanded if, immediately after it had been softened in potassium hydroxide, it was gently teased out in water with fine forceps under the microscope. The conjunctival appendages or the vesica should never be pulled in this process. After expansion male genitalia were transferred to dilute glycerine solution, in which medium they were examined and drawn, using a squared eye piece. The following species were examined: *Alydus calcaratus* Linn., *Daclera punctata* Sign. (Alydinae), *Micrelytra fossularum* Rossi, *Acestra sinica* Dallas, *A. malayana* Dist. *Stachyolobus cuspidatus* Dist. (Micrelytrinae) and all known species of Leptocorisinae.


Sp1
Sp2
S1
S2
S3
S4
S5
Si2
S6
S7
T8
Sp8
Pt8
Gx
T9
T10
T11
1
0.5 mm.
Pt9
2
St10
St11
Op
Sp8
6
3
0.25 mm.
4
5
8
9
10
11
12
6
7
0.25 mm.
0.5 mm.

Morphology

The alydid abdomen consists of eleven segments in both the sexes and for convenience can be divided into pregenital, genital and postgenital regions.

Pregenital region

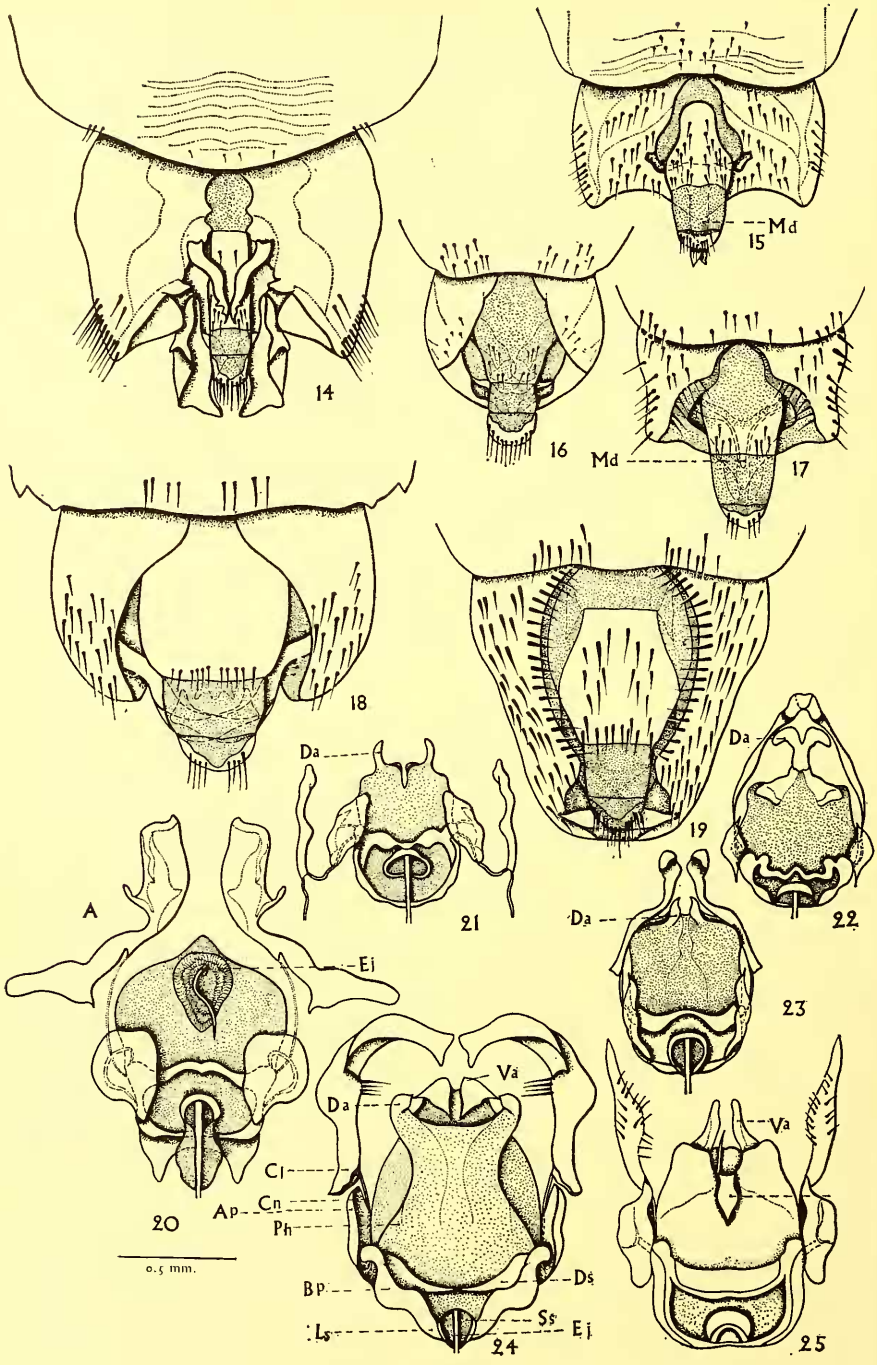
This region includes the first to seventh segments (fig. 1 and 2). Typically as suggested by Tower (1913) each segment has dorsal (= notal or tergal), ventral (= sternal) and lateral (= connexival or paratergital) areas but the connexiva is not differentiated on the second and seventh segments. Snodgrass (1933) and Akbar (1958) have shown them in their figures of other coreoids. The tergum and sternum of first segment are partially fused with those of the second and the partial suture between them is visible (fig. 1 and 2). This partial suture has not been noted before in the lygaeid *Oncopeltus fasciatus* Dallas. Bonhag & Wick (1953) reported that the venter of the first abdominal segment was membraneous and indistinct and was fused with the venter of the second segment. Esaki & Miyamoto (1955) suggested after studying the larvae of *Pseudovelia tibialis* Esaki & Miyamoto that in the adult condition the first sternum was fused with the second. Although Snodgrass recognised the fusion of the tergum of the first and second segment in *Anasa tristis* Degeer, he believed that the first sternum was absent and Akbar (1958) considered that this was the condition in a species of *Leptocorisa.*

The spiracles of segment one are present on the dorso-lateral membranous area. On the dorsum the third to seventh segments are partially fused together, the sutures between third to sixth segments could be seen only on the connexiva and that between sixth and seventh only on the lateral extremities with a faint indication medially. Akbar (1958) has erred in showing distinct sutures. Bonhag & Wick (1953) however stated that the dorsum of the pregenital region was not incisively divided into segmental areas except for inflected lines of demarcation at the anterior and posterior ends of the sixth and seventh segments. Medially the posterior margins of the fifth and the sixth segments are sinuate (fig. 1) as has been shown by Snodgrass (1933), but Akbar failed to observe this in a *Leptocorisa.* The sutures on the connexiva are well marked, as is that between the seventh and eighth segments in the female. The tergal plates of segment third to sixth are separated from connexiva by a membrane.

Ventrally the abdominal segments are well marked by transverse sutures, but as has been shown by Akbar (1958), there is no longitudinal suture demarcating

---

Fig. 1—4, *Daclera punctata*: 1, female abdomen, dorsal view; 2, ventral view; 3, male, 8th. abdominal segment, ventral view; 4, 9th. segment (proctiger pulled out), dorsal view; fig. 5—7, female spermatheca: 5, *Daclera punctata*; 6, *Micrelytra fossularum*; 7, *Leptocorisa chinensis*; fig. 8—13, posterior margin of seventh abdominal sternum of female, ventral view: 8, *Alydus calcaratus*; 9, *Daclera punctata*; 10, *Micrelytra fossularum*; 11, *Acestra sinica*; 12, *Leptocorisa acuta*; 13, *Leptocorisa lepida.* Gx = gonocoxae; Pt = paratergite; S (1—7) = abdominal segments; Si = sinuation showing dorsal abdominal glands; St = sternum· T = tergum


14
15
Md
16
17
Md
18
19
Da
21
Da
22
Da
23
A
Ej
20
Ap
Cl
Cn
Ph
0.5 mm.
Va
Da
Bp
Ls
Ds
Ss
Ej
24
Va
25

parasternites. The shape of the posterior margin of seventh segment is highly variable, being characteristic for different species.

Genital region in male

This includes eight and ninth segments which are highly modified, bearing the genitalia. The eighth segment (fig. 3) is of a cap-like shape into which the pygophore or the ninth segment is retracted. It is in turn retracted into the seventh segment and is hardly visible externally. Dorsally it bears an opening which connects the ejaculatory duct with the body cavity. Ventrally it is divided by a transverse suture into an upper and a lower portion. The lower portion is densely punctate and is covered with bristles. The upper portion is membranous. Koch (1957) has shown that this segment was of a similar form in a coreid.

The ninth segment, the pygophore, bears lateral lobes which may be produced and pointed (fig. 14—19), and are characteristics for many species. Crampton (1922) figured them in *Alydus pilosulus* Herrich-Schäffer and labelled these lobes as pleural process or pleuroprocess. The posterior margin is entire and sometimes bears an acute median process as in *Micrelytra fossularum* (fig. 15). Sometimes as in *Alydus calcaratus* the posterior of the dorsum also bears appendages (fig. 14) laterally on either side. The raised posterior wall of the pygophore is seen after the dorsal flap is removed. It divides into two lateral connectives running on either side of the aedeagus to join the basal plate. Leston (1955a) called this structure the aedeagal strut; it gives support to the aedeagus during copulation. Akbar (1958) illustrated the raised median portion of the posterior wall of the ninth segment, but he did not show its lateral connectives joining the basal plate. Dupuis (1955) and Ashlock (1957) have termed this structure the "Apodème suspenseur".

The claspers are borne on the ninth segment on either side of the aedeagus and are connected to the ventro-lateral side of the basal plate. In Alydinae these connections are membranous whereas in Micrelytrinae and in many species of the Leptocorisinae they are partly sclerotized. Many terms have been applied to these structures and in a recent review Dupuis (1963) has followed Pruthi (1925), Villiers (1955), and Ashlock (1957) and called them "parameres"; this term has a variety of meanings; in the Heteroptera Qadri (1949), Bonhag & Wick (1953) and Akbar (1958) have used the term for appendages of the aedeagus itself and this is its most usual meaning in other groups (Alam, 1953).

The male intromittent organ occupies the central place inside the pygophore surrounded laterally by the aedeagal strut and basal connectives of the claspers

---

Fig. 14—19, male, terminalia; dorsal view: 14 = *Alydus calcaratus*; 15, *Micrelytra fossularum*; 16, *Stachyolobus cuspidatus*; 17, *Acestra sinica*; 18, *Leptocorisa acuta*; 19, *Stenocoris phthisica*; fig. 20—25, male aedeagus showing connection of claspers with basal plates; dorsal view: 20, *Alydus calcaratus*; 21, *Micrelytra fossularum*; 22, *Stachyolobus cuspidatus*; 23, *Acestra malayana*; 24, *Leptocorisa acuta*; 25, *Stenocoris (Erbula) elegans*. Ap = Apodeme of the basal plate, "pivot"; Bp = basal plate; Cl = claspers; Cn = connective of the claspers; Da = dorsal thecal appendage; Ds = dorsal stapes; Md = median process of the pygophore; Ph = phallosoma, theca; Ss = seminal fluid sac; Va = ventral thecal appendage

and encloses the conjunctiva and vesica. It is termed here the aedeagus following PRUTHI (1925) and many taxonomists. However other terms such as phallus or phallic organ have also been used by QADRI (1949), BONHAG & WICK (1953), ASHLOCK (1957), and AKBAR (1958). The basal portion of the aedeagus supporting the theca is called here the basal plate. It includes the dorsal and the lateral stapes, and the median membranous portion, the septum (fig. 20—25). On the dorsal side medially the ejaculatory duct enters in a sac-like dilatation; a similar structure has been reported in Coreidae and Pentatomidae by QADRI (1949) and LESTON (1955c), respectively, and following BONHAG & WICK (1953) it is referred to as the erection fluid pump. Different terminologies have been used for the basal plate and its parts; they are summarised in the following table.

1. Basal plate

Basal sclerite and phallobase	SNODGRASS (1935)
Articulatory apparatus	BONHAG & WICK (1953)
Basal apparatus	ASHLOCK (1957)
Basal blase	KOCH (1957)

2. Dorsal and lateral stapes

Dorsal and lateral rods	AKBAR (1958)
Stapes	BONHAG & WICK (1953)
Spange	KOCH (1957)

3. Pivot

Capitate process	MICHENER (1944), MARKS (1951) LESTON (1955c)
Connective apodeme	LESTON (1954—55)
Concave apodemal plate	AKBAR (1958)
Promotor apodeme of the phallobase	BONHAG & WICK (1953)

4. Knob of the dorsal stapes

Outer lobes of the basal plate	AKBAR (1958)

The cup-like distal portion of the aedeagus in which the vesica, conjunctiva and its appendages are retracted in normal position, is termed the "theca" following SNODGRASS (1935, 1936), MARKS (1951), SOUTHWOOD (1953), LESTON (1955c), and KELTON (1959). This is partly membranous and partly sclerotized. Usually it bears distally dorsal and ventral pairs of appendages (fig. 24). These are termed here the thecal appendages. They are of characteristic shape in many species. Sometimes the dorsal appendages are united as in *L.* (*Erbula*) *elegans* Blöte and sometimes even absent as in *Alydus calaratus* (fig. 20). PRUTHI (1925) thought incorrectly that they are borne by the conjunctiva and so in his study of a *Leptocorisa* species he termed them conjunctival appendages. These are the appendages that were termed the parameral lobes by QADRI (1949) and others (see above).

The partly membranous endosoma (PRUTHI, 1925) lies within the theca. In the

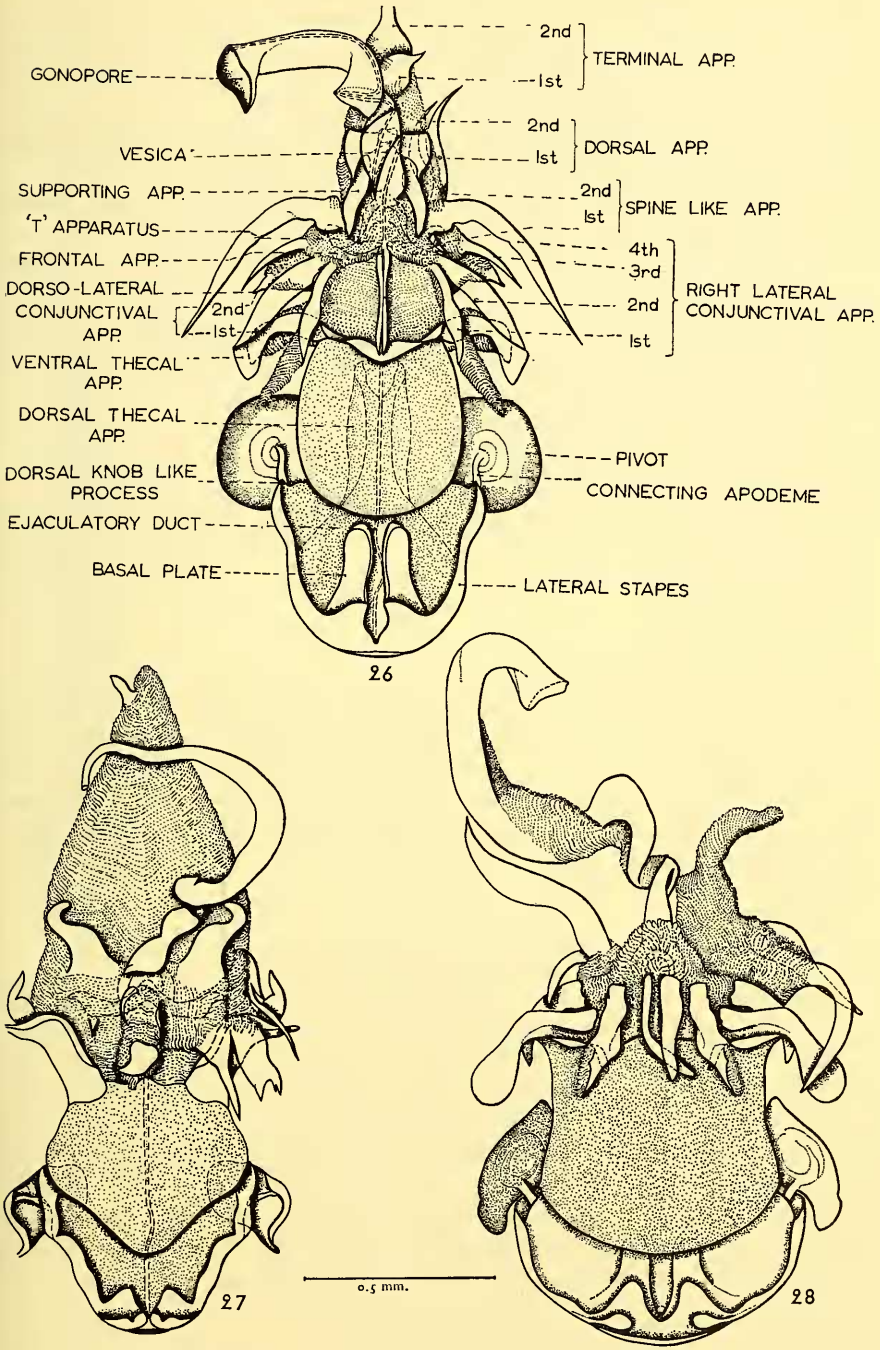


Fig. 26—28, male aedeagus (inflated), ventral view: 26, hypothetical, showing all the appendages found in Leptocorisinae; 27, *Leptocorisa acuta*; 28, *Stenocoris phthisica*

fully everted condition the conjunctiva arises immediately beyond the point of attachment of thecal appendages. In Alydidae the conjunctiva bears sclerotized appendages. The greatest elaboration of these is found in the Leptocorisinae where the following can be recognised (fig. 26): —

a. A frontal appendage attached ventrally near the junction of the theca (sometimes paired).
b. Four lateral appendages on each side. These are described as the first, second, third and fourth left and right respectively.
c. A spine-like appendage is sometimes borne at the base of the second right lateral appendage.
d. A membranous appendage arising on the dorsal surface of the distoconjunctiva near the apex; this appendage sometimes has one or two dorsal appendages at its base and one or two terminal appendages at its apex.
e. A pair of supporting appendages at the base of the vesica.
f. One or two pairs of dorso-lateral conjunctival appendages.
g. Single spine-like appendage at the base of the second dorsal appendage.

Similar appendages of the aedeagus have been used in taxonomic studies in the Miridae (SOUTHWOOD, 1953; CARVALHO & SOUTHWOOD, 1955; KELTON, 1959) and LESTON (1954—55) has figured them in detail for some Pentatomidae and Cydnidae.

Postgenital region in the male

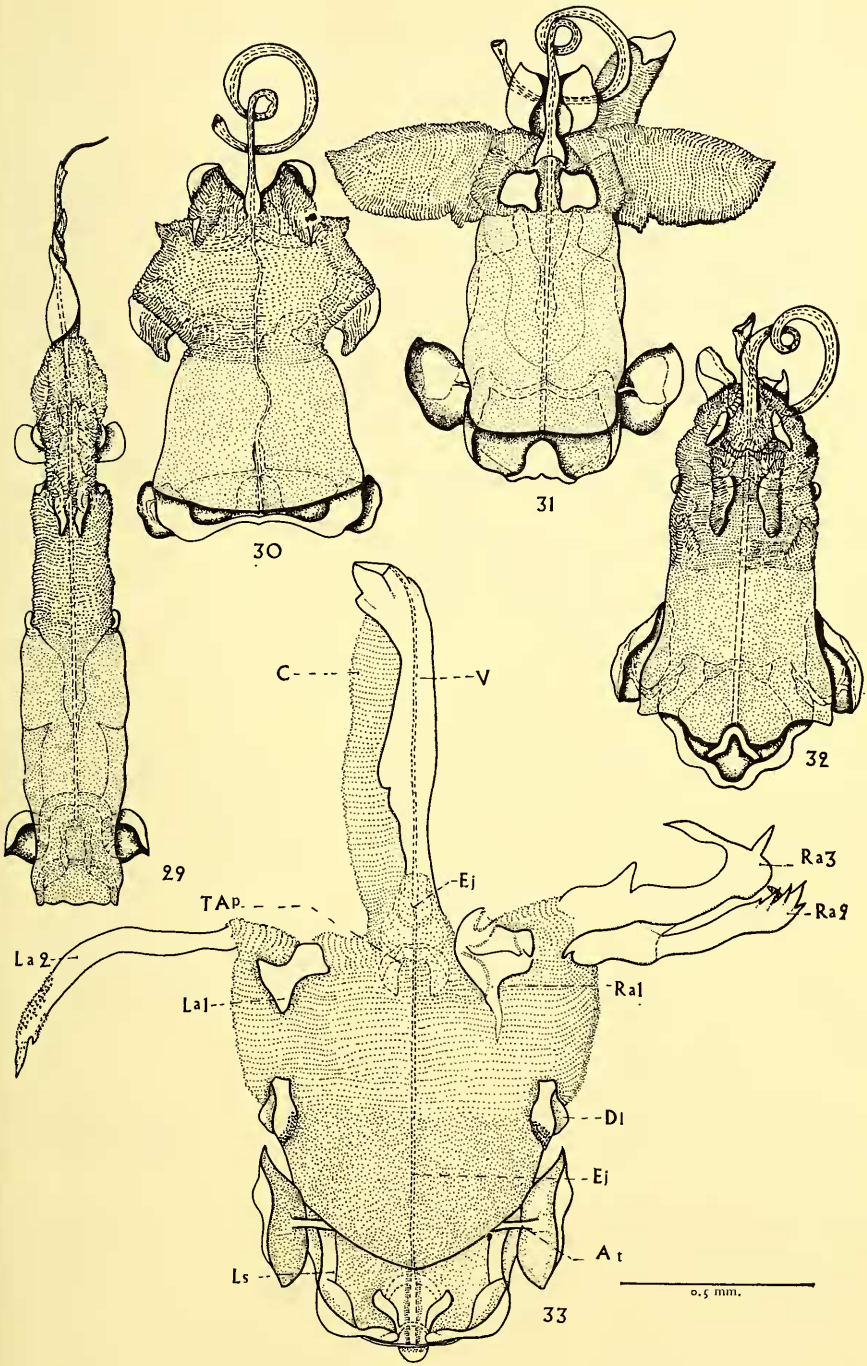
This includes the tenth and eleventh segments and occupies the dorsal median portion of pygophore. The tergum and sternum of the tenth segment are attached dorsally by a membrane to the ninth tergum and are represented by narrow bands covered with setae. They are separated from the eleventh segment by membrane; this segment is retracted within the tenth. Only the distal regions of the eleventh tergum and sternum are sclerotized and setose. The anus is between the eleventh tergum and sternum.

Genital region in the female

In the female the eighth and ninth segments undergo modification to take part in the formation of the ovipositor. The tergal plates of these segments are continued ventrally to form paratergites of corresponding segments. The last pair of spiracles are located on the eighth paratergite. The sterna of these segments are membranous and mostly covered by the seventh sternum and by a ventro-lateral pair of large structures, the first gonocoxae. Ninth venter is represented by the membranous portion between the ninth paratergite. BONHAG & WICK (1953) called the eighth paratergite, the latero-tergite. The ninth paratergite bears dorsally a transverse rib (fig. 35), the apex of which is produced like a knob and fits in the median cavity of the second gonocoxae which is described later. At the base of this rib, there is

---

Fig. 29—33, male, aedeagus (inflated) ventral view: 29, *Alydus calcaratus*; 30, *Stachyolobus cuspidatus*; 31, *Acestra malayana*; 32, *Micrelytra fossularum*; 33, *Daclera punctata*. At = attaching apodeme of the pivot; c = conjunctiva; Dl = dorso-lateral appendage; Ej = ejaculatory duct; Ls = lateral stapes; Ra = right lateral conjunctival appendage; V = vesica


30
31
32
29
C
V
Ej
TAp.
La2
La1
Ra3
Ra2
Ra1
Dl
Ej
At
Ls
33
0.5 mm.

a vertical knob-like structure to which the ninth tergal plate is attached. Medially the transverse rib gives rise to an anterior process which is termed here, after SCUDDER (1959), the gonangulum (fig. 36). This is an important sclerite providing attachments to the first gonocoxae, first gonapophyses and second gonocoxae.

In this family the ovipositor is highly developed, but mostly concealed by the posterior region of the seventh sternum and by the first pair of gonocoxae. In the resting condition only the distal portions of the second gonapophyses are visible. The ovipositor includes the first pair of gonocoxae, the first pair of gonapophyses, the second pair of gonocoxae and the second pair of gonapophyses. As pointed out by SNODGRASS (1933), AKBAR (1958), and SCUDDER (1959) the gonoplocs are absent in this family.

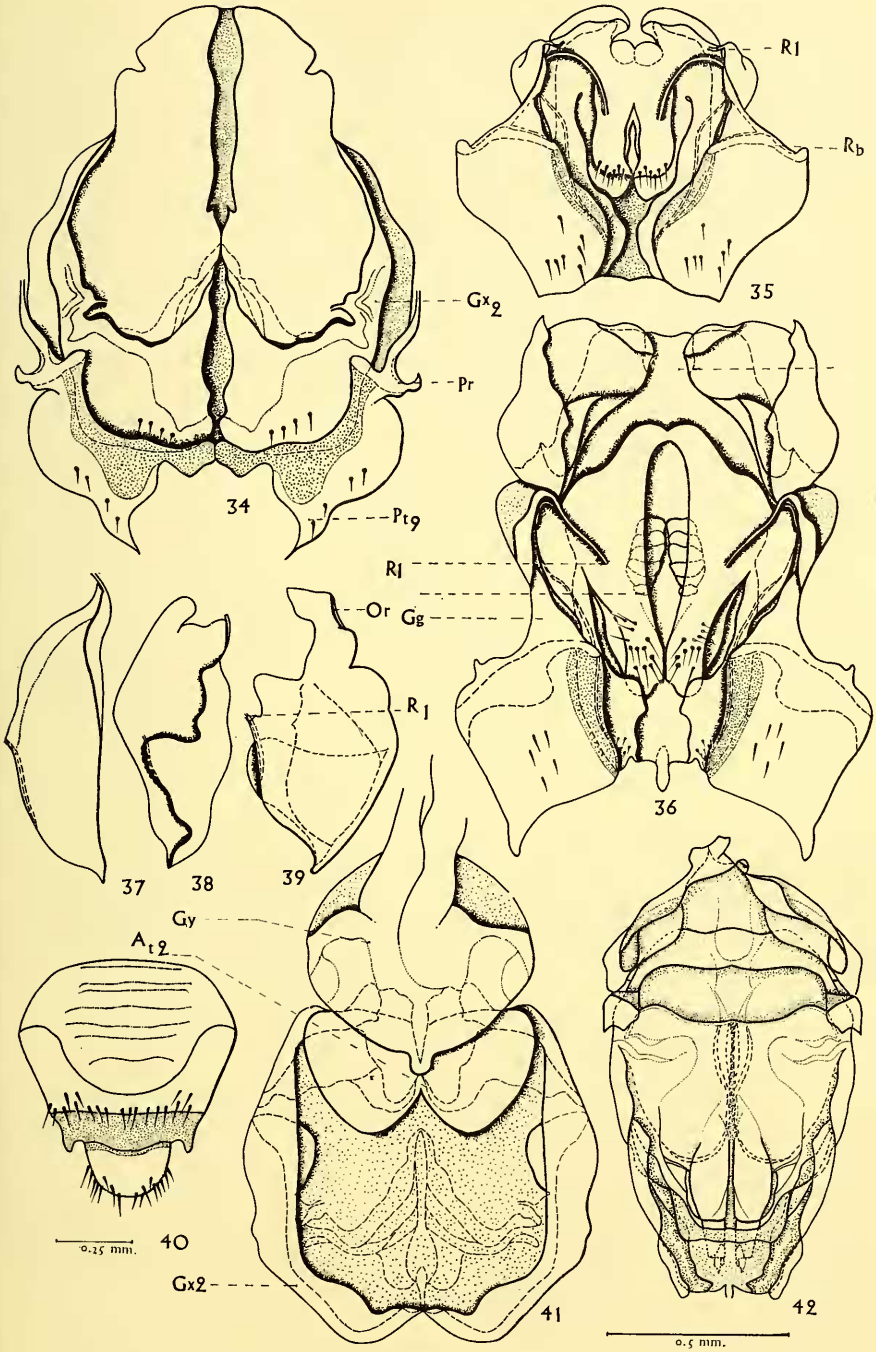
The first gonocoxae are large structures concealing a large portion of the ovipositor (fig. 2). The proximal portion is covered by and attached to the posterior margin of the seventh sternum by a membraneous connection. The base is truncate, so that a knob-like structure is formed on either side. The outer margin may be smooth or roughened and is separated from the eighth paratergite by a membrane. Dorsally the latero-posterior outer margin is attached to the base of the gonangulum by a membranous connection and the inner knob runs into a posteriorly directed thickened margin to which the first gonapophysis is attached. SNODGRASS (1933) and AKBAR (1958) called this thickening the first outer ramus. The first gonocoxae have been called the first valvifer by many workers (e.g., SNODGRASS, 1933; AKBAR, 1958; STYS, 1961) and its form has been found to be characteristic of many species (AHMAD, unpublished).

The first gonapophyses are attached dorsally to the inner margin of the first gonocoxae; they are curved so that the ventral surface is convex. The grooved first inner rami run from them to the apex of the gonangulum and are bent sharply in the middle (fig. 36); they are greatly reduced in the Alydinae, but are well developed in the Micrelytrina and Leptocorisinae. SNODGRASS (1933) and AKBAR (1958) reported their presence in a coreid and an alydid, respectively. SCUDDER (1959) erred in claiming that both the first and the second rami are absent in Alydidae; but his studies were based on alydine species and in this subfamily they are poorly developed and difficult to see. As SCUDDER (1959) recorded, the basivalvulae are not strongly sclerotized. The first gonapophyses have been called the first valvulae by SNODGRASS (1933), AKBAR (1958), STYS (1961), and others.

The second gonocoxae are dorsally attached to the inner distal margin of the ninth paratergite (fig. 34—36) and have a median cavity in which the inner knob of the transverse rib fits; they are attached proximally by a membraneous con-

---

Fig. 34—36. Ovipositor with first gonapophyses and first gonocoxae removed, ventral view: 34, *Alydus calcaratus*; 35, *Micrelytra fossularum*; 36, *Leptocorisa lepida*; fig. 37—39, first gonapophyses, ventral view: 37, *Daclera punctata*; 38, *Micrelytra fossularum*; 39, *Leptocorisa acuta*; fig 40, *Daclera punctata*, male proctiger, ventral view; fig. 41—42, ovipositor with first gonocoxae, first gonapophyses and 9th paratergite removed, dorsal view: 41, *Alydus calaratus*; 42, *Daclera punctata*. At 2 = attachment of the second gonocoxae; Gx 2 = second gonocoxae; Or = outer ramus; P = process of the 9th segment; Pt = paratergite; R = ramus; Rb = rib of the 9th paratergite


R1
Rb
35
Gx2
Pr
34
Pt9
R1
Or
Gg
36
37
38
39
R1
Gy
At2
0.25 mm.
40
Gx2
41
42
0.5 mm.

nection to the apices of the gonangulum and to each other across the midline. Anteriorly the inner margin of each second gonocoxa is attached ventrally to the second gonapophysis, cylindrical elongated structures; their tips are covered with bristles. The ridged outer margin of each gonapophysis forms the second ramus; this runs anteriorly fitting into the grooved first inner ramus, it bends sharply back on itself to join the lateral margin of the second gonocoxae. In some leptocorisids, e.g., *Leptocorisa lepida* Breddin (fig. 36), there are a few pairs of apparently closed sac-like structures on the ventral walls; these are termed the intervalvular sacs. Their function is unknown, but they may secrete some substance during oviposition; they have not been noted by earlier workers and were not found in Alydinae and Micrelytrinae, but in Leptocorisinae they are characteristic of certain genera and species.

The second gonapophyses are fused together dorsally, but their inner ventral edges are free and the space between them leads to the entrance of the female genital chamber which has been termed the gynatrium. This is lying above the base of the second gonocoxae and is complex and sclerotized. The sclerotizations of the gynatrial glands are referred to by STYS (1961), who has suggested that unpaired sclerotizations of the gynatrial wall are characteristic of the Alydinae. However, it has been found that, although this is true for *Alydus calcaratus,* in *Daclera punctata* as in Micrelytrinae and Leptocorisinae the sclerotizations are paired. The oviduct and spermathecal tube open into the gynatrium. The spermatheca is sclerotized and its shape is characteristic for each species. In Leptocorisinae it sometimes has a median flange, as in *L. chinensis*; in Micrelytrinae it is very thin and elongated, whereas in Alydinae it is stout. Previous workers in this field, notably PENDERGAST (1957) and AKBAR (1958), have not described the spermatheca of an Alydine.

Post genital region in the female

This includes the tenth and eleventh segments which are retracted within the posterior end of the ninth paratergite and are similar to those of the male (see above) but are attached by a membrane to the apices of the ninth paratergite. AKBAR (1958) erred in claiming that the eleventh segment was missing in female *Leptocorisa*; BONHAG & WICK (1953) have also found it in *Oncopeltus* (Lygaeidae).

Abdominal characters of Alydid subfamilies

Alydidae (fig. 1—5, 8—9, 14, 20, 29, 33—34, 37 and 40—42)

In male: posterior margin of seventh abdominal tergum usually produced in middle; pygophore without median posterior spine; aedeagus without thecal appendages or dorsal, frontal and supporting conjunctival appendages usually one or two pairs of dorsolateral conjunctival appendages present; ejaculatory duct sometimes sclerotized and arising from vesica like a flagellum. In female: posterior margin of seventh abdominal sternum usually emarginate, without a median split; first and second rami poorly developed; second gonapophyses truncated at apices; spermatheca tubular with a short tube.

Micrelytrinae (fig. 6, 10—11, 15—17, 21—23, 30—32, 35 and 38)

In male: posterior margin of seventh abdominal tergum usually emarginate in

middle; pygophore with median posterior spine; aedeagus with only dorsal pair of thecal appendages, dorsal and frontal conjunctival appendages absent, supporting appendages (at base of vesica) always present, usually one or two pairs of dorsolateral conjunctival appendages; ejaculatory duct never sclerotized. In female: posterior margin of seventh abdominal sternum always with a median split; first and second rami highly developed; second gonapophyses pointed at apices; spermatheca thin with a long, uniformly thin coiled tube.

Leptocorisinae (fig. 7, 12—13, 18—19, 24—25, 27—28, 36 and 39)

In male: posterior margin of seventh abdominal tergum usually truncated; pygophore never with median posterior spine; aedeagus usually with both dorsal and ventral pairs of thecal appendages, usually dorsal and frontal conjunctival appendages present, supporting appendage sometimes absent, dorsolateral conjunctival appendages usually absent; ejaculatory duct never sclerotized. In female: posterior margin of seventh abdominal sternum usually without a median split; first and second rami well developed; second gonapophyses usually rounded at apices; spermatheca usually flask-shaped with a tube of varying length and thickness.

References

Akbar, S. S., 1958. The morphology and life history of *Leptocorisa varicornis* Fabr. (Coreidae, Hemiptera) — a pest of paddy crop in India. *Publ. Aligarh Univ. (Zool. ser.). Ind. Ins. Typ.*, vol. 5, pt. 2, p. 1—50.

Alam, S. M., 1953. The skeleto-muscular mechanism of *Stenobracon deesae* Cameron (Braconidae Hymenoptera) — an ectoparasite of Sugar Cane and Juar borers of India. *Publ. Aligarh Univ. (Zool. ser.). Ind. Ins. Typ.*, vol. 3, pt. 2, p. 1—75.

Ashlock, P. D., 1957. An investigation of the taxonomic value of the phallus in the Lygaeidae (Hemipt. Het.). *Ann. ent. Soc. Amer.*, vol. 50, p. 407—425.

Blöte, H. C., 1937. On African species of *Leptocorixa* Berthold. *Temminckia,* vol. 2, p. 281—296.

Bonhag, P. F. and Wick, J. R., 1953. The functional anatomy of the male and female reproductive system of the milk weed bug *Oncopeltus fasciatus* Dallas (Heteroptera, Lygaeidae). *J. Morph.*, vol. 93, no. 2, p. 117—283.

Carvalho, J. C. M. and Southwood, T. R. E., 1955. Revisao do compleco *Cyrtorhinus* Fieber — *Mecomma* Fieber (Hemiptera-Heteroptera, Miridae). *Bol. Mus. Goeldi (Zool.)*, vol. 11, pt. 1, p. 1—72.

China, W. E., 1924. A preliminary revision of the oriental species of *Leptocorisa* Latr. (Hemiptera, Coreidae). *Bull. ent. Res.*, vol. 14, pt. 3, p. 235—239.

Crampton, G. C., 1920. Remarks on the basic plan of the terminal abdominal segments of ♂ of winged insects. *Canad. Ent.*, vol. 52, p. 172—183.

———, 1922. The genitalia of the males of certain Hemiptera (Heteroptera) and Homoptera. *Bull. Brooklyn ent. Soc.*, vol. 17, p. 46—55.

Dupuis, C., 1955. Les génitalia des Hémiptères Hétéroptères (Génitalia externes des deux sexes; voies ectodermiques femelles). Revue de la morphologie lexique de la nomenclature. Index bibliographique analytique. *Mém. Mus. Hist. nat., Paris, sér. A,* Zool., vol. 6, p. 183—278.

———, 1963. Progrés récents de l'étude des genitalia de Hétéroptères (Étude bibliographique critique). Thèse présentées à la Faculté des Sciences de l'Université de Paris pour obtiner le grade de Docteur des sciences naturelles, pt. 2, Mus. Hist. Nat., Paris, p. 1—100.

Esaki, T., and Miyamoto, S., 1955. Veliidae of Japan and adjacent territory (Hemiptera-Heteroptera). 1. *Microvelia* Westwood and *Pseudovelia* Hoberlandt of Japan. *Sieboldia,* vol. 1, no. 3, p. 169—203.

KELTON, L. A., 1959. Male genitalia as taxonomic characters in the Miridae (Hemiptera). *Canad. Ent.*, vol. 91, suppl. 11, p. 1—72.

KOCH, H., 1957. Über den Bau und die Funktion des Kopulationsapparates der Coreiden (Hem. Heter.). *Abh. Mus. Tierk., Dresden,* vol. 23, p. 241—255.

LESTON, D., 1954c. Notes on the Ethiopian Pentatomoidea (Hemiptera), XX. on *Steganocerus* Mayr. (Scutelleridae) and the structure of the aedeagus. *Proc. R. ent. Soc. Lond.*, ser. B, vol. 23, p. 164—166.

———, 1954d. Wing venation and male genitalia of *Tessaratoma* Berthold with remarks on Tessaratominae Stål (Hemiptera, Pentatomidae). *Proc. R. ent. Soc. Lond.*, ser. A, vol. 29, p. 9—16.

———, 1954e. The male genitalia of *Sehirus bicolor* (L.) (Heteroptera, Cydnidae). *J. Soc. Brit. Ent.*, vol. 5, pt. 2, p. 75—78.

———, 1954f. Notes on the Ethiopian Pentatomoidea (Hemiptera), XII. On some specimens from Southern Rhodesia, with an investigation of certain features in the morphology of *Afrius figuratus* (Germar) and remarks upon the male genitalia in Amyotinae. *Occ. pap. nat. Mus. S. Rhod.*, no. 19, p. 678—686.

———, 1955a. Remarks upon the male and female genitalia and abdomen of Aradidae (Heteroptera). *Proc. R. ent. Soc. Lond.*, ser. A, vol. 30, p. 63—69.

———, 1955b. The function of the conjunctiva in copulation of a shield bug, *Piezodorus lituratus* (Fabricius) (Hemiptera, Pentatomidae). *J. Soc. Brit. Ent.*, vol. 5, pt. 3, p. 101—105.

———, 1955c. The aedeagus of Dinidorinae (Hemiptera, Pentatomidae). *Ent. mon. Mag.*, vol. 91, p. 214—215.

MARKS, E. D., 1951. Comparative studies of the male genitalia of the Hemiptera (Homoptera, Heteroptera). *J. Kans. ent. Soc.*, vol. 24, p. 134—141.

MICHENER, C. D., 1944. A comparative study of the appendages of the eighth and ninth abdominal segments of insects. *Ann. ent. Soc. Amer.*, vol. 37, p. 336—351.

PENDERGAST, J. G., 1957. Studies on the reproductive organs of the Heteroptera with a consideration on their bearing on classification. *Trans. R. ent. Soc. Lond.*, vol. 109, p. 1—63.

PRUTHI, H. S., 1925. The morphology of the male genitalia in Rhynchota. *Trans. R. ent. Soc. Lond.*, vol. 73, p. 127—254.

QADRI, M. A. H., 1949. On the morphology and post embryonic development of the male genitalia and their ducts in Hemiptera (Insecta). *J. zool. Soc. India,* vol. 1, p. 129—143.

SCUDDER, G. G. E., 1959. The female genitalia of the Heteroptera, morphology and bearing on classification. *Trans. R. ent. Soc. Lond.*, vol. 3, p. 405—467.

SLATER, J. A., 1955. A revision of the sub-family Pachygronthinae of the world (Hemiptera, Lygaeidae). *Philipp. J. Sci.*, vol. 84, no. 1, p. 1—160.

SNODGRASS, R. E., 1933. Morphology of the insect abdomen, pt. 2. The genital ducts and the ovipositor. *Smithson. misc. Coll.*, Washington, vol. 89, No. 8, p. 1—148.

———, 1935. Principles of Insect Morphology. New York, p. 1—667.

———, 1936. Morphology of the insect abdomen, pt. 3. The male genitalia. *Smithson. misc. Coll.*, Washington, vol. 95, no. 14, p. 1—96.

SOUTHWOOD, T. R. E., 1953. The morphology and taxonomy of the genus *Orthotylus* Fieber (Hemiptera, Miridae) with special reference to the British species. *Trans. R. ent. Soc. Lond.*, vol. 104, p. 415—449.

STYS, P., 1961. Morphology of abdomen and female ectodermal genitalia of trichophorous Heteroptera and bearing on their classification. *XI Int. Cong. ent.*, vol. 1, p. 37—43.

TOWER, D. G., 1913. The external anatomy of the squash bug, *Anasa tristis* Degeer, (Hemiptera, Coreidae). *Ann. ent. Soc. Amer.*, vol. 6, p. 427—437.

VILLIERS, A., 1955. Les *Leptocorixa* (Hem., Coreidae) de la collection de l'Ifan. *Bull. Inst. franç. Afr. noire,* ser. A, vol. 17, p. 1141—1144.

———, 1963. Les *Leptocorixa* Africains et malgaches du Museum de Paris (Hem., Coreidae). *Bull. Inst. franc. Afr. noire,* vol. 25, p. 229—234.